

Document number and name	40 CFR part 600 reference
ASTM E 29–67 (Reapproved 1973) Standard Recommended Practice for Indicating which Places of Figures are to be Considered Significant in Specified Limiting Values.	600.002–93(a)(30); 600.113–93(d)
ASTM D 1298–85 (Reapproved 1990) Standard Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.	600.113–93(c)(1)(i), (c)(2)(i)(A), (c)(2)(i)(B), (c)(2)(ii); 600.510–93(g)(1)(ii)(B), (g)(2)(ii)(B).
ASTM D 3343–90 Standard Test Method for Estimation of Hydrogen Content of Aviation Fuels	600.113–93(c)(1)(iii), (c)(2)(ii).
ASTM D 3338–92 Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels.	600.113–93(c)(1)(iii).
ASTM D 240–92 Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter.	600.113–93(c)(2)(iii); 600.510–93(g)(1)(ii)(A), (g)(2)(ii)(A).

(2) [Reserved]

[59 FR 39652, Aug. 3, 1994]

### Subpart B—Fuel Economy Regulations for 1978 and Later Model Year Automobiles—Test Procedures

SOURCE: 42 FR 45657, Sept. 12, 1977, unless otherwise noted.

#### § 600.101–86 General applicability.

(a) The provisions of this subpart are applicable to 1986 and later model year gasoline-fueled and diesel automobiles.

[49 FR 13849, Apr. 6, 1984]

#### § 600.101–93 General applicability.

The provisions of this subpart are applicable to 1993 and later model year gasoline-fueled, diesel-fueled, alcohol-fueled, natural gas-fueled, alcohol dual fuel, and natural gas dual fuel automobiles.

[59 FR 39652, Aug. 3, 1994]

#### § 600.102–78 Definitions.

The definitions in § 600.002 apply to this subpart.

#### § 600.103–78 Abbreviations.

The abbreviations in § 600.003 apply to this subpart.

#### § 600.104–78 Section numbering, construction.

The section numbering system set forth in § 600.004 applies to this subpart.

#### § 600.105–78 Recordkeeping.

The recordkeeping requirements set forth in § 600.005 apply to this subpart.

#### § 600.106–78 Equipment requirements.

The requirements for test equipment to be used for all fuel economy testing are given in §§ 86.106, 86.107, 86.108, 86.109, and 86.111 of this chapter, as applicable.

#### § 600.107–78 Fuel specifications.

(a) The test fuel specifications for gasoline-fueled automobiles are given in paragraph (a)(1) of § 86.113 of this chapter.

(b) The test fuel specifications for diesel automobiles are given in paragraphs (b) (1) and (2) of § 86.113 of this chapter.

#### § 600.107–93 Fuel specifications.

(a) The test fuel specifications for gasoline-fueled automobiles are given in § 86.113(a) (1) and (2) of this chapter.

(b) The test fuel specifications for diesel-fueled automobiles are given in § 86.113(b) (1) through (3) of this chapter.

(c) The test fuel specifications for methanol fuel used in Otto-cycle automobiles are given in § 86.113(a) (3) and (4) of this chapter.

(d) The test fuel specifications for methanol fuel used in diesel cycle automobiles are given in § 86.113(b) (4) through (6) of this chapter.

(e) The test fuel specifications for mixtures of petroleum and methanol fuels for methanol dual fuel vehicles are given in § 86.113(d) of this chapter.

(f) The specification range of the fuels to be used under paragraphs (c) and (d) of this section shall be reported in accordance with § 86.090–21(b)(3) of this chapter.

[59 FR 39652, Aug. 3, 1994]

**§ 600.108-78 Analytical gases.**

The analytical gases for all fuel economy testing must meet the criteria given in § 86.114 of this chapter.

**§ 600.109-78 EPA driving cycles.**

(a) The driving cycle to be utilized for generation of the city fuel economy data is prescribed in § 86.115 of this chapter.

(b) The driving cycle to be utilized for generation of the highway fuel economy data is specified in this paragraph.

(1) The Highway Fuel Economy Driving Schedule is set forth in appendix I to this part. The driving schedule is defined by a smooth trace drawn through the specified speed versus time relationships.

(2) The speed tolerance at any given time on the dynamometer driving schedule specified in appendix I, or as printed on a driver's aid chart approved by the Administrator, when conducted to meet the requirements of paragraph (b) of § 600.111 is defined by upper and lower limits. The upper limit is 2 mph higher than the highest point on trace within 1 second of the given time. The lower limit is 2 mph lower than the lowest point on the trace within 1 second of the given time. Speed variations greater than the tolerances (such as may occur during gear changes) are acceptable provided they occur for less than 2 seconds on any occasion. Speeds lower than those prescribed are acceptable provided the vehicle is operated at maximum available power during such occurrences.

(3) A graphic representation of the range of acceptable speed tolerances is found in paragraph (c) of § 86.115 of this chapter.

**§ 600.110-78 Equipment calibration.**

The equipment used for fuel economy testing must be calibrated according to the provisions of § 86.116 of this chapter.

**§ 600.111-80 Test procedures.**

(a) The test procedures to be followed for generation of the city fuel economy data are those prescribed in §§ 86.127-94 through 86.138-78 of this chapter, as applicable. (The evaporative and refuel-

ing loss portions of the test procedure may be omitted unless specifically required by the Administrator.)

(b) The test procedures to be followed for generation of the highway fuel economy data are those specified in § 600.111-78 (b) through (h) inclusive.

(1) The Highway Fuel Economy Dynamometer Procedure consists of a preconditioning highway driving sequence and a measured highway driving sequence.

(2) The highway fuel economy test is designated to simulate non-metropolitan driving with an average speed of 48.6 mph and a maximum speed of 60 mph. The cycle is 10.2 miles long with 0.2 stops per mile and consists of warmed-up vehicle operation on a chassis dynamometer through a specified driving cycle. A proportional part of the diluted exhaust emissions is collected continuously for subsequent analysis using a constant volume (variable dilution) sampler. Diesel dilute exhaust is continuously analyzed for hydrocarbons using a heated sample line and analyzer.

(3) Except in cases of component malfunction or failure, all emission control systems installed on or incorporated in a new motor vehicle must be functioning during all procedures in this subpart. The Administrator may authorize maintenance to correct component malfunction or failure.

(c) *Transmission.* The provisions of § 86.128 of this chapter apply for vehicle transmission operation during highway fuel economy testing under this subpart.

(d) *Road load power and test weight determination.* Section 86.129 of this chapter applies for determination of road load power and test weight for highway fuel economy testing. The test weight for the testing of a certification vehicle will be that test weight specified by the Administrator under the provisions of part 86. The test weight for a fuel economy data vehicle will be that test weight specified by the Administrator from the test weights covered by that vehicle configuration. The Administrator will base his selection of a test weight on the relative projected sales volumes of the various test weights within the vehicle configuration.

(e) *Vehicle preconditioning.* The Highway Fuel Economy Dynamometer Procedure is designed to be performed immediately following the Federal Emission Test Procedure, §§86.127 through 86.138 of this chapter. When conditions allow, the tests should be scheduled in this sequence. In the event the tests cannot be scheduled within three hours of the Federal Emission Test Procedure (including one hour hot soak evaporation loss test, if applicable) the vehicle should be preconditioned as in paragraph (e)(1) or (2) of this section, as applicable.

(1) If the vehicle has experienced more than three hours of soak (68°F–86°F) since the completion of the Federal Emission Test Procedure, or has experienced periods of storage outdoors, or in environments where soak temperature is not controlled to 68°F–86°F, the vehicle must be preconditioned by operation on a dynamometer through one cycle of the EPA Urban Dynamometer Driving Schedule, §86.115 of this chapter.

(2) In unusual circumstances where additional preconditioning is desired by the manufacturer, the provisions of paragraph (a)(3) of §86.132 of this chapter apply.

(f) *Highway fuel economy dynamometer procedure.* (1) The dynamometer procedure consists of two cycles of the Highway Fuel Economy Driving Schedule (§600.109 (b)) separated by 15 seconds of idle. The first cycle of the Highway Fuel Economy Driving Schedule is driven to precondition the test vehicle and the second is driven for the fuel economy measurement.

(2) The provisions of paragraphs (b), (c), (e), (f), (g), and (h) of §86.135 *Dynamometer procedure* of this chapter, apply for highway fuel economy testing.

(3) Only one exhaust sample and one background sample are collected and analyzed for hydrocarbons (except diesel hydrocarbons which are analyzed continuously), carbon monoxide, and carbon dioxide.

(4) The fuel economy measurement cycle of the test includes two seconds of idle indexed at the beginning of the second cycle and two seconds of idle indexed at the end of the second cycle.

(g) *Engine starting and restarting.* (1) If the engine is not running at the initi-

ation of the highway fuel economy test (preconditioning cycle), the start-up procedure must be according to the manufacturer's recommended procedures.

(2) False starts and stalls during the preconditioning cycle must be treated as in paragraphs (d) and (e) of §86.136 of this chapter. If the vehicle stalls during the measurement cycle of the highway fuel economy test, the test is voided, corrective action may be taken according to §86.079-25 of this chapter, and the vehicle may be rescheduled for test. The person taking the corrective action shall report the action so that the test records for the vehicle contain a record of the action.

(h) *Dynamometer test run.* The following steps must be taken for each test:

(1) Place the drive wheels of the vehicle on the dynamometer. The vehicle may be driven onto the dynamometer.

(2) Open the vehicle engine compartment cover and position the cooling fan(s) required. Manufacturers may request the use of additional cooling fans for additional engine compartment or under-vehicle cooling and for controlling high tire or brake temperatures during dynamometer operation.

(3) Preparation of the CVS must be performed before the measurement highway driving cycle.

(4) Equipment preparation. The provisions of paragraphs (b) (3) through (5) inclusive of §86.137 of this chapter apply for highway fuel economy test except that only one exhaust sample collection bag and one dilution air sample collection bag need be connected to the sample collection systems.

(5) Operate the vehicle over one Highway Fuel Economy Driving Schedule cycle according to the dynamometer driving schedule specified in paragraph (b) of §600.109.

(6) When the vehicle reaches zero speed at the end of the preconditioning cycle, the driver has 17 seconds to prepare for the emission measurement cycle of the test. Reset and enable the roll revolution counter.

(7) Operate the vehicle over one Highway Fuel Economy Driving Schedule cycle according to the dynamometer driving schedule specified in paragraph

(b) of § 600.109 while sampling the exhaust gas.

(8) Sampling must begin two seconds before beginning the first acceleration of the fuel economy measurement cycle and must end two seconds after the end of the deceleration to zero. At the end of the deceleration to zero speed, the roll or shaft revolutions must be recorded.

[42 FR 45657, Sept. 12, 1977, as amended at 43 FR 52929, Nov. 14, 1978; 59 FR 16309, Apr. 6, 1994]

**§ 600.111-93 Test procedures.**

(a) The test procedures to be followed for generation of the city fuel economy data are those prescribed in §§ 86.127 through 86.138 of this chapter, as applicable, except as provided for in paragraph (d) of this section. (The evaporative loss portion of the test procedure may be omitted unless specifically required by the Administrator.)

(b) The test procedures to be followed for generation of the highway fuel economy data are those specified in paragraphs (b) through (j) of this section.

(1) The Highway Fuel Economy Dynamometer Procedure consists of preconditioning highway driving sequence and a measured highway driving sequence.

(2) The highway fuel economy test is designated to simulate non-metropolitan driving with an average speed of 48.6 mph and a maximum speed of 60 mph. The cycle is 10.2 miles long with 0.2 stop per mile and consists of warmed-up vehicle operation on a chassis dynamometer through a specified driving cycle. A proportional part of the diluted exhaust emission is collected continuously for subsequent analysis of hydrocarbons, carbon monoxide, carbon dioxide using a constant volume (variable dilution) sampler. Diesel dilute exhaust is continuously analyzed for hydrocarbons using a heated sample line and analyzer. Methanol and formaldehyde samples are collected and individually analyzed for methanol-fueled vehicles (measurement of methanol and formaldehyde may be omitted for 1993 through 1994 model year methanol-fueled vehicles provided a HFID calibrated on meth-

anol is used for measuring HC plus methanol).

(3) Except in cases of component malfunction or failure, all emission control systems installed on or incorporated in a new motor vehicle must be functioning during all procedures in this subpart. The Administrator may authorize maintenance to correct component malfunction or failure.

(c) *Transmission.* The provisions of § 86.128 of this chapter apply for vehicle transmission operation during highway fuel economy testing under this subpart.

(d) *Road load power and test weight determination.* Section 86.129 of this chapter applies for determination of road load power and test weight for highway fuel economy testing. The test weight for the testing of a certification vehicle will be that test weight specified by the Administrator under the provisions of part 86 of this chapter. The test weight for a fuel economy data vehicle will be that test weight specified by the Administrator from the test weights covered by that vehicle configuration. The Administrator will base his selection of a test weight on the relative projected sales volumes of the various test weights within the vehicle configuration.

(e) *Vehicle preconditioning.* The Highway Fuel Economy Dynamometer Procedure is designed to be performed immediately following the Federal Emission Test Procedure, §§ 86.127 through 86.138 of this chapter. When conditions allow, the tests should be scheduled in this sequence. In the event the tests cannot be scheduled within three hours of the Federal Emission Test Procedure (including one hour hot soak evaporative loss test, if applicable) the vehicle should be preconditioned as in paragraph (e) (1) or (2) of this section, as applicable.

(1) If the vehicle has experienced more than three hours of soak (68 °F-86 °F) since the completion of the Federal Emission Test Procedure, or has experienced periods of storage outdoors, or in environments where soak temperature is not controlled to 68 °F-86 °F, the vehicle must be preconditioned by operation on a dynamometer through

one cycle of the EPA Urban Dynamometer Driving Schedule, §86.115 of this chapter.

(2) In unusual circumstances where additional preconditioning is desired by the manufacturer, the provisions of §86.132(a)(3) of this chapter apply.

(f) *Highway fuel economy dynamometer procedure.* (1) The dynamometer procedure consists of two cycles of the Highway Fuel Economy Driving Schedule (§600.109(b)) separated by 15 seconds of idle. The first cycle of the Highway Fuel Economy Driving Schedule is driven to precondition the test vehicle and the second is driven for the fuel economy measurement.

(2) The provisions of paragraphs (b), (c), (e), (f), (g) and (h) of §86.135 *Dynamometer procedure* of this chapter, apply for highway fuel economy testing.

(3) Only one exhaust sample and one background sample are collected and analyzed for hydrocarbons (except diesel hydrocarbons which are analyzed continuously), carbon monoxide, and carbon dioxide. Methanol and formaldehyde samples (exhaust and dilution air) are collected and analyzed for methanol-fueled vehicles (measurement of methanol and formaldehyde may be omitted for 1993 through 1994 model year methanol-fueled vehicles provided a HFID calibrated on methanol is used for measuring HC plus methanol).

(4) The fuel economy measurement cycle of the test includes two seconds of idle indexed at the beginning of the second cycle and two seconds of idle indexed at the end of the second cycle.

(g) *Engine starting and restarting.* (1) If the engine is not running at the initiation of the highway fuel economy test (preconditioning cycle), the start-up procedure must be according to the manufacturer's recommended procedures.

(2) False starts and stalls during the preconditioning cycle must be treated as in §86.136(d) and (e) of this chapter. If the vehicle stalls during the measurement cycle of the highway fuel economy test, the test is voided, corrective action may be taken according to §86.079-25 of this chapter, and the vehicle may be rescheduled for test. The person taking the corrective action shall report the action so that the test

records for the vehicle contain a record of the action.

(h) *Dynamometer test run.* The following steps must be taken for each test:

(1) Place the drive wheels of the vehicle on the dynamometer. The vehicle may be driven onto the dynamometer.

(2) Open the vehicle engine compartment cover and position the cooling fans(s) required. Manufacturers may request the use of additional cooling fans for additional engine compartment or under-vehicle cooling and for controlling high tire or brake temperatures during dynamometer operation.

(3) Preparation of the CVS must be performed before the measurement highway driving cycle.

(4) Equipment preparation. The provisions of §86.137(b)(3) through (6) of this chapter apply for highway fuel economy test except that only one exhaust sample collection bag and one dilution air sample collection bag need be connected to the sample collection systems.

(5) Operate the vehicle over one Highway Fuel Economy Driving Schedule cycle according to the dynamometer driving schedule specified in §600.109(b).

(6) When the vehicle reaches zero speed at the end of the preconditioning cycle, the driver has 17 seconds to prepare for the emission measurement cycle of the test. Reset and enable the roll revolution counter.

(7) Operate the vehicle over one Highway Fuel Economy Driving Schedule cycle according to the dynamometer driving schedule specified in §600.109(b) while sampling the exhaust gas.

(8) Sampling must begin two seconds before beginning the first acceleration of the fuel economy measurement cycle and must end two seconds after the end of the deceleration to zero. At the end of the deceleration to zero speed, the roll or shaft revolutions must be recorded.

(i) For methanol dual fuel automobiles, the procedures of §600.111 (a) and (b) shall be performed for each of the required test fuels:

(1) Gasoline or diesel fuel as specified in §600.107 (a) and (b); and

(2) Methanol fuel as specified in §600.107 (c) and (d); and

(3) A mixture containing 50% gasoline or diesel and 50% methanol by volume, applicable during model years 1993 through 1995; or

(4) In lieu of testing using the mixture containing 50% gasoline or diesel and 50% methanol by volume, the manufacturer must provide a written statement attesting that the equal or superior energy efficiency is attained while using the 50% gasoline or diesel and 50% methanol mixture compared to using gasoline.

[59 FR 39652, Aug. 3, 1994]

**§ 600.112-78 Exhaust sample analysis.**

The exhaust sample analysis must be performed according to § 86.140 of this chapter.

**§ 600.113-78 Fuel economy calculations.**

The calculations of vehicle fuel economy values require the weighted grams/mile values for HC, CO, and CO<sub>2</sub> for the city fuel economy test and the grams/mile values for HC, CO, and CO<sub>2</sub> for the highway fuel economy test. The city and highway fuel economy values must be calculated by the procedures of this section. A sample calculation appears in appendix II to this part.

(a) Calculate the weighted grams/mile values for the city fuel economy test for HC, CO, and CO<sub>2</sub> as specified in § 86.144 of this chapter.

(b)(1) Calculate the mass values for the highway fuel economy test for HC, CO, and CO<sub>2</sub> as specified in paragraph (b) of § 86.144 of this chapter.

(2) Calculate the grams/mile values for the highway test for HC, CO, and CO<sub>2</sub> by dividing the mass values obtained in (b)(1) by the actual distance traveled, measured in miles, as specified in paragraph (h) of § 86.135 of this chapter.

(c) Calculate the city fuel economy and highway fuel economy from grams/mile values for HC, CO, and CO<sub>2</sub>. The emission values (obtained per paragraph (a) or (b) as applicable) used in each calculation of this section shall be rounded in accordance with § 86.079-26(a)(6)(ii). The CO<sub>2</sub> values (obtained per paragraph (a) or (b) of this section as applicable) used in each calculation in this section are rounded to the nearest gram/mile.

(d) For gasoline-fueled automobiles, calculate the fuel economy in miles per gallon of gasoline by dividing 2421 by the sum of three terms:

(1) 0.866 multiplied by HC (in grams/miles as obtained in paragraph (c)),

(2) 0.429 multiplied by CO (in grams/miles as obtained in paragraph (c), and

(3) 0.273 multiplied by CO<sub>2</sub> (in grams/mile as obtained in paragraph (c) of this section).

Round to quotient to the nearest 0.1 mile per gallon.

(e) For diesel powered automobiles, calculate the fuel economy in miles per gallon of diesel fuel by dividing 2778 by the sum of three terms:

(1) 0.866 multiplied by HC (in grams/mile as obtained in paragraph (c) of this section),

(2) 0.429 multiplied by CO (in grams/mile as obtained in paragraph (c)), and

(3) 0.273 multiplied by CO<sub>2</sub> (in grams/mile as obtained in paragraph (c)).

Round the quotient to the nearest 0.1 mile per gallon.

[42 FR 45657, Sept. 12, 1977, as amended at 43 FR 52929, Nov. 14, 1978]

**§ 600.113-88 Fuel economy calculations.**

The Administrator will use the calculation procedure set forth in this paragraph for all official EPA tests. For the 1988 model year, manufacturers may choose to use this procedure or use the calculation procedure described in § 600.113-78. However, once a manufacturer uses this procedure, it must be used for all subsequent tests. This procedure must be used by manufacturers for 1989 and later model years. The calculations of the weighted fuel economy values require input of the weighted grams/mile values for HC, CO and CO<sub>2</sub> for both the city fuel economy test and the highway fuel economy test. Additionally, for tests of gasoline-fueled vehicles, the specific gravity, carbon weight fraction and net heating value of the test fuel must be determined. The city and highway fuel economy values shall be calculated as specified in this section. A sample appears in appendix II to this part.

(a) Calculate the weighted grams/mile values for the city fuel economy test for HC, CO, and CO<sub>2</sub> as specified in

§86.144 of this chapter. For tests of gasoline-fueled vehicles, measure and record the test fuel's properties as specified in paragraph (c) of this section.

(b)(1) Calculate the mass values for the highway fuel economy test for HC, CO, and CO<sub>2</sub> as specified in paragraph (b) of §86.144 of this chapter. For tests of gasoline-fueled vehicles, measure and record the test fuel's properties as specified in paragraph (c) of this section.

(2) Calculate the grams/mile values for the highway fuel economy test for HC, CO, and CO<sub>2</sub> by dividing the mass values obtained in paragraph (b)(1) of this section, by the actual distance traveled, measured in miles, as specified in paragraph (h) of §86.135 of this chapter.

(c) Gasoline test fuel properties shall be determined by analysis of a fuel sample taken from the fuel supply. A sample shall be taken after each addition of fresh fuel to the fuel supply. Additionally, the fuel shall be resampled once a month to account for any fuel property changes during storage. Less frequent resampling may be permitted if EPA concludes, on the basis of manufacturer-supplied data, that the properties of test fuel in the manufacturer's storage facility will remain stable for a period longer than one month. The fuel samples shall be analyzed to determine the following fuel properties:

(1) Specific gravity per ASTM D 1298.  
(2) Carbon weight fraction per ASTM D 3343.

(3) Net heating value (Btu/lb) per ASTM D 3338.

(d) Calculate the city fuel economy and highway fuel economy from the grams/mile values for HC, CO, CO<sub>2</sub> and, for test of gasoline-fueled vehicles, the test fuel's specific gravity, carbon weight fraction and net heating value. The emission values (obtained per paragraph (a) or (b) of this section, as applicable) used in each calculation of this section shall be rounded in accordance with §86.084-26(a)(6)(iii). The CO<sub>2</sub> values (obtained per paragraph (a) or (b) of this section, as applicable) used in each calculation of this section shall be rounded to the nearest gram/mile. The specific gravity and the carbon weight fraction (obtained per para-

graph (c) of this section) shall be recorded using three places to the right of the decimal point. The net heating value (obtained per paragraph (c) of this section) shall be recorded to the nearest whole Btu/lb. These numbers shall be rounded in accordance with the "Rounding Off Method" specified in ASTM E 29-67.

(e) For gasoline-fueled automobiles, the fuel economy in miles per gallon is to be calculated using the following equation:

$$\text{mpg} = (5174 \times 10^4 \times \text{CWF} \times \text{SG}) / [((\text{CWF} \times \text{HC}) + (0.429 \times \text{CO})) + (0.273 \times \text{CO}_2)] \times ((0.6 \times \text{SG} \times \text{NHV}) + 5471)]$$

Where:

HC=Grams/mile HC as obtained in paragraph (d) of this section.

CO=Grams/mile CO as obtained in paragraph (d) of this section.

CO<sub>2</sub>=Grams/mile CO<sub>2</sub> as obtained in paragraph (d) of this section.

CWF=Carbon weight fraction of test fuel as obtained in paragraph (d) of this section.

NHV=Net heating value by mass of test fuel as obtained in paragraph (D) of this section.

SG=Specific gravity of test fuel as obtained in paragraph (d) of this section.

Round the calculated result to the nearest 0.1 miles per gallon.

(f) For diesel automobiles, calculate the fuel economy in miles per gallon of diesel fuel by dividing 2778 by the sum of three terms:

(1) 0.866 multiplied by HC (in grams/miles as obtained in paragraph (d) of this section),

(2) 0.429 multiplied by CO (in grams/mile as obtained in paragraph (d) of this section), and

(3) 0.273 multiplied by CO<sub>2</sub> (in grams/mile as obtained in paragraph (d) of this section).

Round the quotient to the nearest 0.1 mile per gallon.

[51 FR 37851, Oct. 24, 1986]

#### **§600.113-93 Fuel economy calculations.**

The Administrator will use the calculation procedure set forth in this paragraph for all official EPA testing of vehicles fueled with gasoline, diesel, methanol or natural gas fuel. The calculations of the weighted fuel economy values require input of the weighted grams/mile values for total hydrocarbons (HC), carbon monoxide (CO),

and carbon dioxide (CO<sub>2</sub>); and, additionally for methanol-fueled automobiles, methanol (CH<sub>3</sub>OH) and formaldehyde (HCHO); and additionally for natural gas-fueled vehicles non-methane hydrocarbons (NMHC) and methane (CH<sub>4</sub>) for both the city fuel economy test and the highway fuel economy test. Additionally, the specific gravity, carbon weight fraction and net heating value of the test fuel must be determined. The city and highway fuel economy values shall be calculated as specified in this section. A sample appears in appendix II to this part.

(a) Calculate the weighted grams/mile values for the city fuel economy test for HC, CO and CO<sub>2</sub>; and, additionally for methanol-fueled automobiles, CH<sub>3</sub>OH and HCHO; and additionally for natural gas-fueled automobiles NMHC and CH<sub>4</sub> as specified in § 86.144 of this chapter. Measure and record the test fuel's properties as specified in paragraph (c) of this section.

(b)(1) Calculate the mass values for the highway fuel economy test for HC, CO and CO<sub>2</sub>, and where applicable CH<sub>3</sub>OH, HCHO, NMHC and CH<sub>4</sub> as specified in § 86.144(b) of this chapter. Measure and record the test fuel's properties as specified in paragraph (c) of this section.

(2) Calculate the grams/mile values for the highway fuel economy test for HC, CO and CO<sub>2</sub>, and where applicable CH<sub>3</sub>OH, HCHO, NMHC and CH<sub>4</sub> by dividing the mass values obtained in paragraph (b)(1) of this section, by the actual distance traveled, measured in miles, as specified in § 86.135(h) of this chapter.

(c)(1) Gasoline test fuel properties shall be determined by analysis of a fuel sample taken from the fuel supply. A sample shall be taken after each addition of fresh fuel to the fuel supply. Additionally, the fuel shall be resampled once a month to account for any fuel property changes during storage. Less frequent resampling may be permitted if EPA concludes, on the basis of manufacturer-supplied data, that the properties of test fuel in the manufacturer's storage facility will remain stable for a period longer than one month. The fuel samples shall be analyzed to determine the following fuel properties:

(i) Specific gravity per ASTM D 1298 (Incorporated by reference as specified in § 600.011-93).

(ii) Carbon weight fraction per ASTM D 3343 (Incorporated by reference as specified in § 600.011-93).

(iii) Net heating value (Btu/lb) per ASTM D 3338 (Incorporated by reference as specified in § 600.011-93).

(2) Methanol test fuel shall be analyzed to determine the following fuel properties:

(i) Specific gravity using either:

(A) ASTM D 1298 (incorporated by reference as specified in § 600.011-93) for the blend or:

(B) ASTM D 1298 (incorporated by reference as specified in § 600.011-93) for the gasoline fuel component and also for the methanol fuel component and combining as follows:

$$SG = \frac{SG_g \times \text{volume fraction gasoline} + SG_m \times \text{volume fraction methanol}}{\text{volume fraction gasoline} + \text{volume fraction methanol}}$$

(ii)(A) Carbon weight fraction using the following equation:

$$CWF = CWF_g \times MF_g + 0.375 \times MF_m$$

Where:

CWF<sub>g</sub> = Carbon weight fraction of gasoline portion of blend per ASTM D 3343 (incorporated by reference as specified in § 600.011-93).

MF<sub>g</sub> = Mass fraction gasoline =  $(G \times SG_g) / (G \times SG_g + M \times SG_m)$

MF<sub>m</sub> = Mass fraction methanol =  $(M \times SG_m) / (G \times SG_g + M \times SG_m)$

Where:

G = Volume fraction gasoline

M = Volume fraction methanol

SG<sub>g</sub> = Specific gravity of gasoline as measured by ASTM D 1298 (Incorporated by reference as specified in § 600.011-93).

SG<sub>m</sub> = Specific gravity of methanol as measured by ASTM D 1298 (Incorporated by reference as specified in § 600.011-93).

(B) Upon the approval of the Administrator, other procedures to measure the carbon weight fraction of the fuel blend may be used if the manufacturer can show that the procedures are superior to or equally as accurate as those specified in this paragraph (c)(2)(ii).

(iii) Net heating value (BTU/lb) per ASTM D 240 (Incorporated by reference as specified in § 600.011-93).



(3) Natural gas test fuel shall be analyzed to determine the following fuel properties:

(i) Fuel composition per ASTM D 1945-91, Standard Test Method for Analysis of Natural Gas By Gas Chromatography. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103. Copies may be inspected at U.S. EPA, OAR, 401 M Street, SW., Washington, DC 20460, or at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC.

(ii) Specific gravity (based on fuel composition per ASTM D 1945).

(iii) Carbon weight fraction based on the carbon contained only in the HC constituents of the fuel=weight of carbon in HC constituents divided by the total weight of fuel.

(iv) Carbon weight fraction of fuel=total weight of carbon in the fuel (i.e., includes carbon contained in HC and in CO<sub>2</sub>) divided by total weight of fuel.

(d) Calculate the city fuel economy and highway fuel economy from the grams/mile values for total HC, CO, CO<sub>2</sub> and, where applicable, CH<sub>3</sub>OH, HCHO, NMHC and CH<sub>4</sub> and, the test fuel's specific gravity, carbon weight fraction, net heating value, and additionally for natural gas, the test fuel's composition. The emission values (obtained per paragraph (a) or (b) of this section, as applicable) used in each calculation of this section shall be rounded in accordance with § 86.084-26(a)(6)(iii) of this chapter. The CO<sub>2</sub> values (obtained per paragraph (a) or (b) of this section, as applicable) used in each calculation of this section shall be rounded to the nearest gram/mile. The specific gravity and the carbon weight fraction (obtained per paragraph (c) of this section) shall be recorded using three places to the right of the decimal point. The net heating value (obtained per paragraph (c) of this section) shall be recorded to the nearest whole Btu/lb. These numbers shall be rounded in accordance with the "Rounding Off Method" specified in ASTM E 29-67.

(e)(1) For gasoline-fueled automobiles, the fuel economy in miles per gallon is to be calculated using the following equation:

$$\text{mpg} = (5174 \times 10^4 \times \text{CWF} \times \text{SG}) / [((\text{CWF} \times \text{HC}) + (0.429 \times \text{CO}) + (0.273 \times \text{CO}_2)) \times ((0.6 \times \text{SG} \times \text{NHV}) + 5471)]$$

Where:

HC=Grams/mile HC as obtained in paragraph (d) of this section.

CO=Grams/mile CO as obtained in paragraph (d) of this section.

CO<sub>2</sub>=Grams/mile CO<sub>2</sub> as obtained in paragraph (d) of this section.

CWF=Carbon weight fraction of test fuel as obtained in paragraph (d) of this section.

NHV=Net heating value by mass of test fuel as obtained in paragraph (d) of this section.

SG=Specific gravity of test fuel as obtained in paragraph (d) of this section.

(2) Round the calculated result to the nearest 0.1 miles per gallon.

(f)(1) For diesel-fueled automobiles, calculate the fuel economy in miles per gallon of diesel fuel by dividing 2778 by the sum of three terms:

(i) 0.866 multiplied by HC (in grams/miles as obtained in paragraph (d) of this section);

(ii) 0.429 multiplied by CO (in grams/mile as obtained in paragraph (d) of this section); and

(iii) 0.273 multiplied by CO<sub>2</sub> (in grams/mile as obtained in paragraph (d) of this section).

(2) Round the quotient to the nearest 0.1 mile per gallon.

(g) For methanol-fueled automobiles and automobiles designed to operate on mixtures of gasoline and methanol, the fuel economy in miles per gallon is to be calculated using the following equation:

$$\text{mpg} = (\text{CWF} \times \text{SG} \times 3781.8) / ((\text{CWF}_{\text{exHC}} \times \text{HC}) + (0.429 \times \text{CO}) + (0.273 \times \text{CO}_2) + (0.375 \times \text{CH}_3\text{OH}) + (0.400 \times \text{HCHO}))$$

Where:

CWF=Carbon weight fraction of the fuel as determined in paragraph (c)(2)(ii) of this section.

SG=Specific gravity of the fuel as determined in paragraph (c)(2)(i) of this section.

CWF<sub>exHC</sub>=Carbon weight fraction of exhaust hydrocarbons= CWF<sub>g</sub> as determined in (c)(2)(ii) of this section (for M100 fuel, CWF<sub>exHC</sub>=0.866).  
 HC=Grams/mile HC as obtained in paragraph (d) of this section.  
 CO=Grams/mile CO as obtained in paragraph (d) of this section.  
 CO<sub>2</sub>=Grams/mile CO<sub>2</sub> as obtained in paragraph (d) of this section.

CH<sub>3</sub>OH=Grams/mile CH<sub>3</sub>OH (methanol) as obtained in paragraph (d) of this section.

HCHO=Grams/mile HCHO (formaldehyde) as obtained in paragraph (d) of this section.

(h) For automobiles fueled with natural gas, the fuel economy in miles per gallon of natural gas is to be calculated using the following equation:

$$\text{mpg}_e = \frac{\text{CWF}_{\text{HC/NG}} D_{\text{NG}} 121.5}{(0.749)\text{CH}_4 + (\text{CWF}_{\text{NMHC}})\text{NMHC} + (0.429)\text{CO} + (0.273)(\text{CO}_2 - \text{CO}_{2\text{NG}})}$$

Where:

mpg<sub>e</sub>=miles per equivalent gallon of natural gas.

CWF<sub>HC/NG</sub>=carbon weight fraction based on the hydrocarbon constituents in the natural gas fuel as obtained in paragraph (d) of this section.

D<sub>NG</sub>=density of the natural gas fuel [grams/ft<sup>3</sup> at 68 °F (20 °C) and 760 mm Hg (101.3 kPa)] pressure as obtained in paragraph (d) of this section.

CH<sub>4</sub>, NMHC, CO, and CO<sub>2</sub>=weighted mass exhaust emissions [grams/

mile] for methane, non-methane HC, carbon monoxide, and carbon dioxide as calculated in § 600.113.

CWF<sub>NMHC</sub>=carbon weight fraction of the non-methane HC constituents in the fuel as determined from the speciated fuel composition per paragraph (c)(2) of this section.

CO<sub>2NG</sub>=grams of carbon dioxide in the natural gas fuel consumed per mile of travel.

CO<sub>2NG</sub>=FC<sub>NG</sub> D<sub>NG</sub> WF<sub>CO2</sub>

where:

FC<sub>NG</sub> = cubic feet of natural gas fuel consumed per mile

$$= \frac{(0.749)\text{CH}_4 + (\text{CWF}_{\text{NMHC}})\text{NMHC} + (0.429)\text{CO} + (0.273)(\text{CO}_2)}{\text{CWF}_{\text{NG}} D_{\text{NG}}}$$

where:

CWF<sub>NG</sub>=the carbon weight fraction of the natural gas fuel as calculated in paragraph (d) of this section.

WF<sub>CO2</sub>=weight fraction carbon dioxide of the natural gas fuel calculated using the mole fractions and molecular weights of the natural gas fuel constituents per ASTM D 1945.

[59 FR 39654, Aug. 3, 1994; 59 FR 44795, Aug. 30, 1994, as amended at 59 FR 48537, Sept. 21, 1994]

### Subpart C—Fuel Economy Regulations for 1977 and Later Model Year Automobiles—Procedures for Calculating Fuel Economy Values

#### § 600.201-86 General applicability.

(a) The provisions of this subpart are applicable to 1986 and later model year gasoline-fueled and diesel automobiles.

[49 FR 13849, Apr. 6, 1984]

#### § 600.201-93 General applicability.

The provisions of this subpart are applicable to 1993 and later model year